

Project #1: Ship Hydrostatics

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1. Hydrostatics

Ship's lines are designed such that they are fair. To the naval architect, fairness means that the lines exhibit a continuous second derivative. This is the definition of a spline. And before the advent of digital computers, naval architects checked every line on a lines plan for fairness by bending a thin stick of wood, called a batten, on the line. If the line followed the natural bend of the batten, the line was fair. This phenomenon follows from the beam equation, which shows that the energy in the beam is minimum when the beam has a continuous second derivative of position.

Hydrostatics lies at the heart of naval architecture. The hydrostatics of a hull are completely determined by the lines and interpreting them using simple rules of integration. The resulting analysis is presented in the form of graphs, termed the curves of form. In fact, hydrostatics is the foundation of the answer to any naval architecture question.

The responses of the hull to static and dynamic loading situations can be inferred from the curves of form. Their most basic use is to determine the static waterline in various loading scenarios. A more subtle use is to determine the correct placement of the vertical center of gravity to ensure a sea kindly roll period of 10-12 seconds.

2. Assignment

Using the integration rules learned in class, perform a hydrostatic evaluation of the USS OLYMPIA. A half breadth, profile and body plan are included. The lines plan shows 27 stations and 18 waterlines. Use a Design waterline of 22' ABL.

3. Deliverables

All forms and graphs should be completed from the Baseline through the 22' DWL.

Use:

The following waterlines: 0/2/4/6/8/10/12/14/16/18/20/22/24/26/28/30/32/34

The following stations:

-0.25, -0.125, 0, 0.5, 1, 1.5, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 18.5, 19, 19.5, 20

A station spacing of 17 feet

a. Complete **Table of Offsets** using format provided below:

Station	LCG	0	2	4	6	8	10	12	14	16	18	20	22	24	26	28	30	32	34
-0.25	-4.25																		
-0.125	-2.125																		
0	0.000																		
0.5																			
1																			
1.5																			
2																			
3																			
4																			
5																			
6																			
7																			
8																			
9																			
10																			
11																			
12																			
13																			
14																			
15																			
16																			
17																			
18																			
18.5																			
19																			
19.5																			
20																			

b. **Bonjean Curves** for all Stations (from 0 to 26').

c. **Curves of Form** (Displacement and Other Curves) (from 10' to 26') to include:

- (1) Displacement in sea water
- (2) Vertical Center of Buoyancy, KB
- (3) Longitudinal Center of Buoyancy, LCB
- (4) Area of Waterplanes, A_{WP}
- (5) Longitudinal position of CG of waterline, LCF
- (6) Tons per Inch Immersion, TPI
- (7) Area of Midships Section, A_m
- (8) Height of Transverse Metacenter Above Baseline, KM_T
- (9) Longitudinal Metacentric Radius, BM_L
- (10) Moment to Change Trim by One Inch, MT1"

d. **Calculation Sheets for Curves of Form.** Please include any discretized formulas used.

e. For the Design Waterline of 22' ABL, prepare a **Design Summary Table**, to include:

LWL		C_B		L/B	
T		C_P		L/T	
B		C_{WP}		B/T	
Underwater Vol		C_{IT}		$UwVol / L^3$	
A_M		C_{IL}		$Displ / (L/100)^3$	
A_X		C_M		KB	
A_{WP}		BM_T		LCB	
Displacement		BM_L		TPI	
				MT1"	

f. **Plot the sectional area curve at the DWL.**